

## NEW CO ABSORPTION SPECTROSCOPY DATA WITH THE VUV-FTS ON THE DESIRS BEAM LINE AT SOLEIL

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### 1 Introduction

One of the processes controlling the interstellar CO abundance and the ratio of its isotopologues is photodissociation. Accurate modeling requires basic quantitative spectroscopic data for CO and its isotopologues at wavelengths below the dissociation limit, mainly oscillator strengths and predissociation rates. Absorption spectra of  $^{12}\text{C}^{16}\text{O}$  and its isotopologues  $^{13}\text{C}^{16}\text{O}$  and  $^{13}\text{C}^{18}\text{O}$  have been obtained using the VUV FTS installed on the DESIRS beam line at SOLEIL (de Oliveira et al 2007). Spectra have been recorded between 90-100 nm with a resolution  $R=350000$  ( $\sim 12$  times better than those obtained in the same wavelength range with the 6.6 m VUV spectrometer on the SU5 beam line at SUPER-ACO in Orsay).

### 2 Calibration

The four W bands ( $v=0$ ,  $v=0-3$ ) at 97.2, 95.6, 94.1 and 92.5 nm resp. for which oscillator strengths have been previously measured at SUPER-ACO (Eidelsberg et al 2004a) for CO and its isotopologues, have been used as calibration bands in order to obtain an accurate determination of the column density (shown here in Fig. 1, the W(0-0) band recorded both at SuperAco and SOLEIL).

### 3 Experimental

The energy range on the DESIRS beam line at SOLEIL is selected by choosing the appropriate intensity for the undulator installed on the synchrotron e- beam. The CO gas flowing through a 10 cm capillary tube inserted on the light beam path is differentially pumped. The CO absorption spectra are analyzed by a VUV-FT spectrograph. Several pressures are used in order to accurately determine the CO column density and to detect both the lowest absorption features as well as the strongest ones without saturation.

### 4 Preliminary results

The synthetic spectra have been obtained by using energy levels and mixing coefficients deduced from the interacting coefficients given by Eidelsberg & al (2004) and an approximative value of the line width measured for a rotationally resolved R, P or Q line for each band. The final gamma values are then calculated separately for R,P and Q lines by fitting of the whole band. The predissociation rates are then calculated. Results are presented in Fig. 2.

$^{12}\text{C}^{16}\text{O}$ : a cluster of 6 overlapping bands involving the 4 high Rydberg states  $4p\sigma$ ,  $4p\pi(v=2)$ ,  $5p\sigma$ ,  $5p\pi(v=0)$  and  $2^1\Pi$  states of mixed Rydberg valence character, assigned by Eidelsberg et al. (2004b) have been successfully disentangled by taking into account energy levels and interaction coefficients given in the reference. Oscillator strengths and line widths are extracted for each band from the recorded spectra by least square fitting of the

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experimental profiles with synthetic spectra. In addition a narrow continuum is observed under the  $5p\pi(0)$  band.

$^{13}\text{C}^{16}\text{O}$  &  $^{13}\text{C}^{18}\text{O}$ : the  $4p\sigma^1\Sigma^+(2)$  band which is Franck-Condon forbidden is not observed or very weak and only a few lines of the perturber  $\text{II}^1\Pi(v')$  appear. With the exception of the very diffuse  $\text{I}^1\Pi(v')$  band towards the long wavelengths, the rotational lines of the 3 strongest bands:  $4p\pi^1\Pi(2)$ ,  $5p\pi^1\Pi(0)$  and  $5p\sigma^1\Sigma^+(0)$  have smaller predissociation widths than the corresponding bands in  $^{12}\text{C}^{16}\text{O}$  and the widths can be measured directly on the spectrum for many lines.

## 5 Perspectives

A similar work is in progress for new bands recorded in the 91.3-91.7 nm range.

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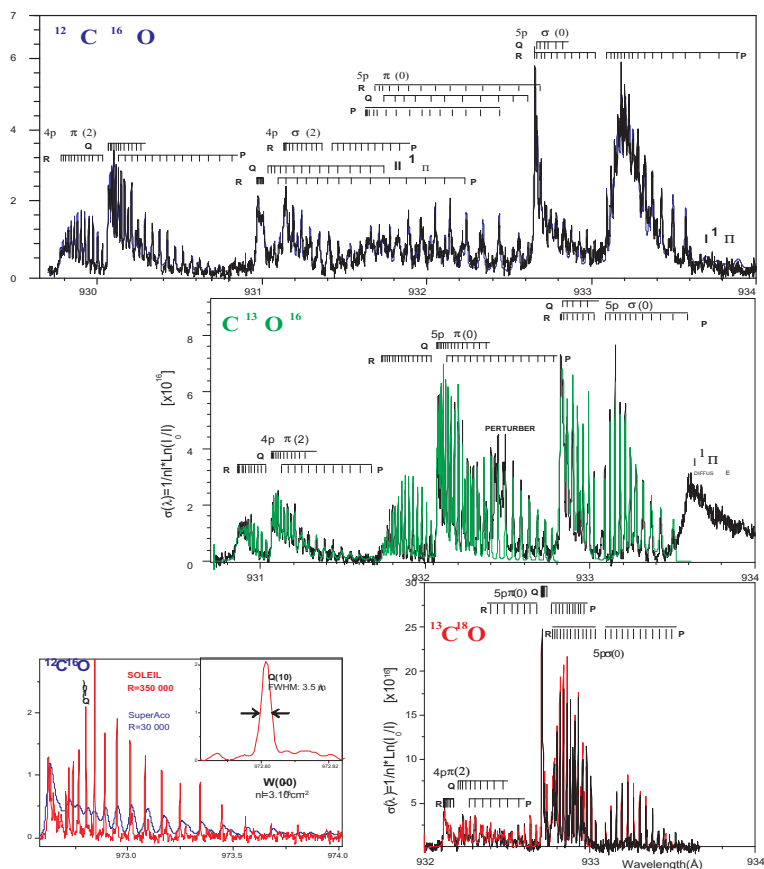


Fig. 1. Right, top to bottom:  $^{12}\text{C}^{16}\text{O}$ ,  $^{13}\text{C}^{16}\text{O}$  &  $^{13}\text{C}^{18}\text{O}$  spectra (same wavelength scale). Left bottom: Calibration line

Band	$f$ -values* $10^3$								Predissociation rates $k^a q^b$ $k = k_e + k_r \rho^c X$ and $X = J^*(J+1)$				
	$^{12}\text{C}^{16}\text{O}$			$^{13}\text{C}^{16}\text{O}$			$^{13}\text{C}^{18}\text{O}$		$^{12}\text{C}^{16}\text{O}$	$^{13}\text{C}^{16}\text{O}$	$^{13}\text{C}^{18}\text{O}$		
	Present	E91	S91	?	Present	E91	?	Present	Present	U94	Present	Present	
$4p\pi(2)$	930.03	7.61(0.47)	6.3	7.3(0.7)	931.03	7.43	6.17	932.17	9.98	$k_{e,r} = 0.86(0.02) + 0.65(0.02)^* X$ $k_r = 0.86(0.015) + 0.65(0.002)^* X$	-	$k_{e,r} = 0.76 + 0.03^* X$ $k_r = 0.70 + 0.019^* X$	$k_{e,r} = 0.87 + 0.043^* X$ $k_r = 1.08 + 0.0005^* X$
$\xi$	930.99	4.96(0.31)			not observed			not observed		2.2	-	-	
$4p\sigma(2)$	931.36	3.03(0.21)			not observed			not observed		2.2	<3.0	-	
$\xi(0)$	931.64	8.65(0.54)		21.6(2.2)	932.04	14.47	33.69	932.69	19.04	2.2	2.7(0.4)	$k_{e,r} = 0.95 + 0.011^* X$ $k_r = 0.84 + 0.011^* X$	$k_{e,r} = 0.43 + 0.001^* X$ $k_r = 0.43 + 0.01^* X$
$\xi(0)$	933.02	15.27(0.95)		8,40 P branch	933.03	17.13		933.04	16.33	$k_{e,r} = 0.86(0.015) + 0.65(0.002)^* X$ up to $J=7$	$k_{e,r} = 0.34(0.20) + 0.65(0.15)^* X$	$k_{e,r} = 0.76 + 0.04^* X$ up to $J=7$	$k_{e,r} = 0.1$ up to $J=7$
$\xi$	933.18	5.89(0.56)		16.5(1.6)	933.59	10.20	9.98	935.48	5.15	2.2 to 10.8		Diffuse	Diffuse
$\xi$		50.91	50.2	53.8(5.4)	49.18	49.84	50.50						

Fig. 2. Oscillator strengths and predissociation rates for the bands appearing in the 92.9-93.5 nm range in  $^{12}\text{C}^{16}\text{O}$ ,  $^{13}\text{C}^{16}\text{O}$  &  $^{13}\text{C}^{18}\text{O}$ . E91=Eidelsberg et al (1991). S91=Stark et al (1991). U94=Ubachs et al (1994).